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First record and geographic range extension of the coccolithophore *Scyphosphaera apsteinii* Lohman, 1902 (Haptophyta: Pontosphaeraceae) from the Pacific coast of Mexico

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Abstract: The coccolithophorid *Scyphosphaera apsteinii* is here reported for the first time from waters off the west coast of the Baja California Peninsula. *Scyphosphaera apsteinii* is the type species of the genus *Scyphosphaera* and had hitherto been recorded only in the Atlantic and Indian Oceans, the Gulf of Mexico, the Mediterranean, and the Caribbean Seas. Specimens were found in samples collected in nets off Isla de Guadalupe in January 2013. This recording thus extends the geographical distribution of *S. apsteinii* from the Central Pacific (Hawaii) to the Eastern Pacific (NW Mexico).

Key words: Eastern Pacific, haptophytes, new recording, nannoplankton

The coccolithophorids are exclusively marine haptophytes that are among the most characteristic microorganisms in the ocean (Reynolds 2006). They have characteristic calcified scales called coccoliths that cover the cell surface, at least in one phase of their life-cycle. Also, they constitute a major component of planktonic communities, and are distributed in oceans worldwide (Okada and McIntyre 1977; Frada et al. 2010). Traditionally, coccolithophore taxonomy has been based mainly on the morphology of the coccoliths, cell shape, coccosphere arrangement, and the presence of different types of coccoliths on a single cell (Faber and Preisig 1994). There are an estimated 200 living species (Chrétiennot-Dinnet 1990). Most cocolithophorids inhabit tropical or sub-tropical oceanic waters, though other species are neritic or found in both regions (Hernández-Becerril et al. 2001). García-Romero (2012) reported 94 taxa of coccolitophorides off Bahía Magdalena where *Emiliania huxleyi*, *Gephyrocapsa oceanica*, *Syracosphaera orbiculus* and *Florisphaera profunda* were the most abundant species.

The genus *Scyphosphaera* Lohmann (Haptophyta: Pontosphaeraceae) was established in 1902 for cells that bear flat, plate-like muroliths, and large, vase-shaped lopadoliths (Siesser 1998). It has been proposed that *Scyphosphaera apsteinii* Lohman, the type species of the genus, is the oldest scyphosphaerid present in the oceans, having evolved ~50 Mya (Rade 1975). The molecular taxonomy of *S. apsteinii* places this species among the Zygodiscales (Liu et al. 2009), and it is one of the few known, extant scyphosphaerids in the oceans today; the others are *S. cohenii* (Siesser 1998) and *S. porosa* (Frada et al. 2009). *Scyphosphaera apsteinii* has been reported in the Atlantic and Indian Oceans, the Mediterranean and Caribbean Seas, and the Central Pacific Ocean (Cros and Fortuño 2002). However, despite its worldwide distribution, sightings of this taxon are scarce. In Mexican waters it has only been recorded in the Gulf of Mexico (Gaarder and Hasle 1971), and despite the importance of these organisms, studies of coccolithophorids in Mexico are scarce. Gaarder and Hasle (1971) studied their floristics and systematics in the Gulf of Mexico. Hernández-Becerril (1987) studied their distribution in the Gulf of California, and later (Hernández-Becerril et al. 2001) studied the morphology, systematics, and floristics of the coccolithophorids along the west coast of the Baja California peninsula.

Here, we report for the first time the presence of *Scyphosphaera apsteinii* from northwestern Mexico, in waters around Isla Guadalupe located off the west coast of the Baja California Peninsula, a finding that extends its geographic distribution.

The Biosphere Reserve of Isla de Guadalupe is located 256 km west of the Baja California Peninsula (29°03′ N, 118°17′ W; Figure 1), within the influence of

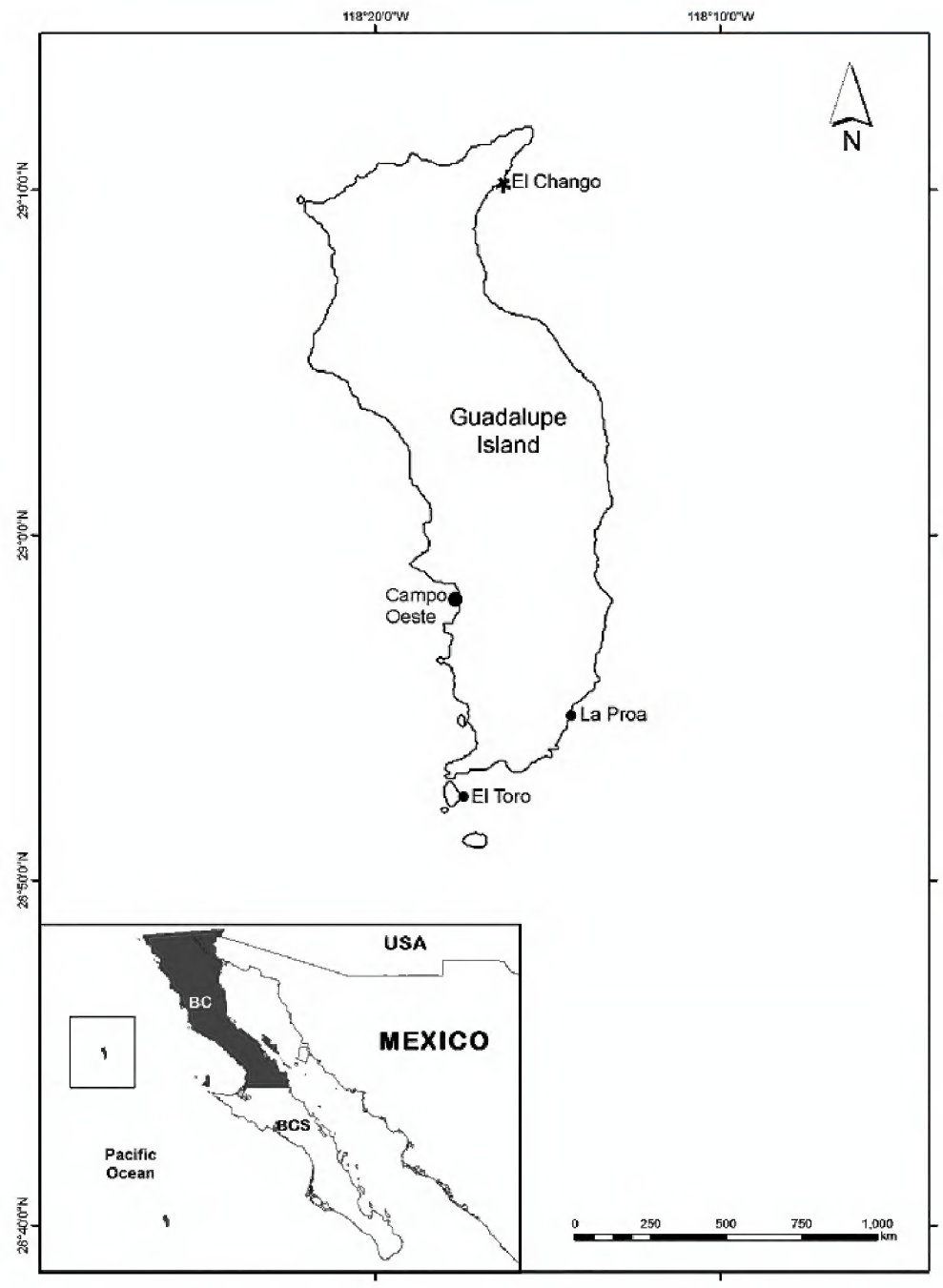

Figure 1. Location of sampling stations at Isla Guadalupe. *collection site El Chango.

the California Current (Lynn and Simpson 1987). On 17 January 2013 at the Chango site (Figure 1), three surface horizontal tows were conducted using a 20-µm mesh net with a mouth 50 cm in diameter. Samples collected (250 ml) were immediately preserved in a formaldehyde solution (4% final concentration). Sea-surface temperature, salinity, and pH were measured at the site with a field multi-sensor (Horiba U10, Kyoto, Japan). Phytoplanton samples were analyzed under a compound Zeiss microscope. *Scyphosphaera apsteinii* was identified using the taxonomic keys by Cros and Fortuño (2002) and Omura et al. (2012). A digital Konus camera (8.1 MP) was used to record images. Samples containing specimens of *S. apsteinii* were deposited in the Phytoplankton Laboratory of CICIMAR-IPN.

The specimens of *S. apsteinii* from Isla Guadalupe coastal waters were found near the surface only in El Chango. At the time, temperature of 16.6°C, pH 8.0, and salinity 35 were recorded. Salinity and temperature match those reported by Lynn and Simpson (1987). *Scyphosphaera apsteinii* is predominantly distributed in warm waters; however, this island is influenced by water of low temperature and salinity, characteristic of the California Current.

Although most coccolithophorids are small and regarded as nannoplankton, *S. apsteinii* is a large form. In what follows, its dimensions, according to Cros and Fortuño (2002) and Young et al. (2005) are compared with those of our specimens. Cells (Figure 2) have a diameter of 20–25 µm vs. 21.42 µm in our specimens, excluding lopadoliths, which places them just above the artificial threshold that defines the group size. It has coccoliths consisting of cribriliths that are about 10–13 µm long vs. 5.35-7.14 µm in our specimens, with a smooth border and a perforated central area. And lopadoliths, which show a web-like pattern of transverse and longitudinal ridges on the surface measuring 7–17 µm long vs. 6.42–7.14 µm in our specimens (bottom plate), and 16–25 µm high vs. 7.85–12.5 µm.

Given its unique taxonomic and morphological char-

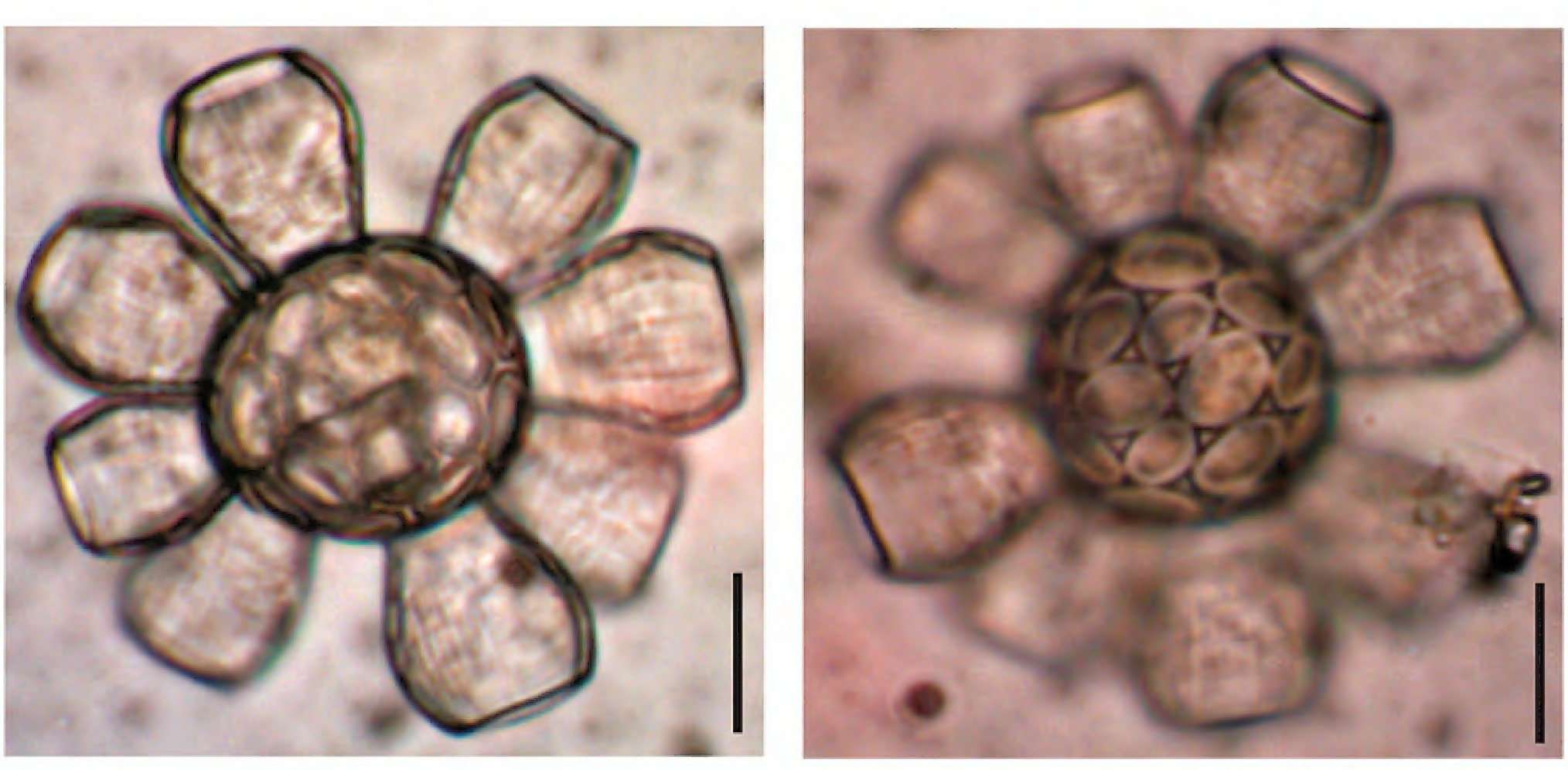

Figure 2. Distinct views (focus) of the same specimen of *Scyphosphaera apsteinii* showing vase-shaped lopadoliths, and coccoliths. Scale bars=10µm

acteristics, *S. apsteinii* is an important taxon for study (Drescher et al. 2012). Its relatively large size and unique calcification characteristics, together with the taxonomic and evolutionary relationship with other species in the Calciohaptophycideae suggest *S. apsteinii* as a base model for further studies of coccolithophore physiology (Drescher et al. 2012). However, our records show that studies on floristic, ecological, and distributional records for this species are still lacking. *S. apsteinii* has not been reported to form blooms, though it appears to have a wide distribution in the world oceans (Frada et al. 2010). It is a rather common, albeit rarely abundant, component of coccolithophore communities (Frada 2009). As mentioned above, it has been reported primarily in tropical and sub-tropical warm waters, in the Mediterranean Sea, the Atlantic, Indian and Pacific Oceans (Hawaii), the Gulf of Mexico and the Caribbean (Winter and Siesser 1994; Omura et al. 2012). In the Pacific Ocean, Ziveri et al. (1995) carried out a study on the density variations of the coccolithophorids in the southern California Bight (from Point Conception to San Diego) that spanned one annual cycle (1991–1992). This is an area that, while close to Isla de Guadalupe, has not provided any recordings of *S. apsteinii*. Furthermore, Hernández-Becerril et al. (2001) first systematic and floristic study of the coccolithophorids along the east coast of Baja California recorded 24 taxa, including 15 new recordings for the Mexican Pacific, but this species was not recorded.

So, notwithstanding the wide distribution of *S. apsteinii*, recordings are scarce, and this is the first time that it has been recorded on the Pacific side of the Baja California peninsula (Mexico). Finally, intense samplings targeting *S. apsteinii* are required in order to understand why such a conspicuous taxon has proven to be so elusive.

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